L Number	Hits	Search Text	DB	Time stamp
1	102	IPVD or (ionized adj physical adj vapor adj deposition)	USPAT; US-PGPUB	2003/04/05 14:09
2	58	(IPVD or (ionized adj physical adj vapor adj deposition)) and titanium	USPAT; US-PGPUB	2003/04/05 14:53

	U	1 [1]	Document ID	Issue Date	Pages
1	☐	☒	US 20030059538 A1	20030327	18
2	☐	☒	US 20030057527 A1	20030327	16
3	☐	☒	US 20030003652 A1	20030102	12
4	☐	☒	US 20020137338 A1	20020926	7
5	☐	☒	US 20020132474 A1	20020919	12

	Title	Current OR	Current XRef
1	Integration of barrier layer and seed layer	427/304	427/123; 427/248.1; 427/255.28; 427/402
2	Integration of barrier layer and seed layer	257/642	
3	Method and installation for fabricating one-sided buried straps	438/243	438/386
4	Method for depositing copper films having controlled morphology and semiconductor wafers produced thereby	438/687	257/750; 257/753; 428/620; 428/647; 428/649; 428/652; 438/654; 438/658; 438/680
5	Barrier-metal-free copper damascene technology using atomic hydrogen enhanced reflow	438/643	257/750; 257/751; 257/752; 438/632; 438/638; 438/639; 438/646; 438/775

	Retrieval Classif	Inventor	S	C	P	2	3	4	5
1		Chung, Hua et al.	☒	☐	☐	☐	☐	☐	☐
2		Chung, Hua et al.	☒	☐	☐	☐	☐	☐	☐
3		Gobel, Bernd et al.	☒	☐	☐	☐	☐	☐	☐
4		Yasar, Tugrul et al.	☒	☐	☐	☐	☐	☐	☐
5		Ahn, Kie Y. et al.	☒	☐	☐	☐	☐	☐	☐

US-PAT-NO: 5990004

DOCUMENT-IDENTIFIER: US 5990004 A

TITLE: Method for forming a tungsten plug and a barrier layer in a contact of high aspect ratio

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To increase the ohmic contact between the barrier layer and the silicon containing layer, a Ti layer is frequently deposited between the silicon containing layer and the TiN layer. The TiN layer is used as a barrier layer between a metal layer and a silicon containing layer. When forming a plug in a contact, the barrier layer is usually used to prevent the spike produced at the interface of the plug (usually formed of metal tungsten or aluminum) and the silicon containing layer. The TiN (**titanium** nitride) is usually used to form the barrier layer mentioned above. So the Ti layer together with the TiN layer is frequently used before the deposition of plug or interconnection.

First, use a physical vapor deposition to form a **titanium** layer on a topography of the semiconductor wafer to increase the ohmic contact to the exposed silicon contained layer. Thus a first portion of the **titanium** layer is formed on the dielectric layer, and a second portion of the **titanium** layer is formed on the exposed silicon contained layer. Next, remove the first portion of the **titanium** layer to expose the dielectric layer. Finally, use a chemical vapor deposition (CVD) method to form the barrier layer on the dielectric layer

and the first portion of the **titanium** layer to prevent said silicon contained
layer from exposure.

FIG. 3 shows a cross sectional view of a semiconductor wafer after forming
the barrier layer on the bottom of the contact, in addition, the WF.sub.6
reacts with the substrate and the exposed **titanium** layer, a worm hole is formed
thereof;

forming a **titanium** layer on said dielectric layer and said exposed silicon
contained layer, a first portion of said **titanium** layer being on said
dielectric layer, a second portion of said **titanium** layer being on said exposed
silicon contained layer, due to an aspect ratio of said contact opening, when
forming said **titanium** layer, said second portion of said **titanium** layer at a
center of said contact opening being thicker than said second portion of said
titanium layer at a corner of said contact opening;

removing said first portion of said **titanium** layer;

forming a barrier layer on said dielectric layer and said second portion of
said **titanium** layer by a chemical vapor deposition (CVD), said barrier layer
being formed by said chemical vapor deposition using a material as a source,
said material can be chosen from the group consisting of: TiCl3, NH3 and TDMAT
and TDEAT, said **titanium** layer being formed other than said chemical vapor
deposition; and

forming said tungsten plug in said contact opening using a WF.sub.6, said
barrier layer being used for preventing said WF.sub.6 from reacting with said
titanium layer and said silicon contained layer.

3. The method as claim 1, wherein said **titanium** layer

is formed by an
ionized physical vapor deposition (ionized PVD).

4. The method as claim 1, wherein said **titanium** layer is formed by a
physical vapor deposition using a collimator.

5. The method as claim 1, wherein said barrier layer is a **titanium** nitride
(TiN) layer.

L Number	Hits	Search Text	DB	Time stamp
1	1	("6168690").PN.	USPAT; US-PGPUB	2003/04/05 16:21
3	58	IPVD or (ionized adj physical adj vapor adj deposition) same (aspect adj ratio)	USPAT; US-PGPUB	2003/04/05 16:41
4	55	IPVD or (ionized adj physical adj vapor adj deposition) with (aspect adj ratio)	USPAT; US-PGPUB	2003/04/05 16:41
2	83	IPVD or (ionized adj physical adj vapor adj deposition) and (aspect adj ratio)	USPAT; US-PGPUB	2003/04/05 16:57